

Topic 4:
Design, implementation and programming of the
Pushbutton Switch Interface
for the Slow Control System MPD-NICA,
on the NImyRIO and LabView platforms.¹

Marek Jerzy PERYT

*Faculty of Physics, Warsaw University of Technology
Koszykowa 75, 00-662 Warszawa, Poland
Joint Institute for Nuclear Research
Dubna, J. Curie 6*

(Accepted June, 2018)

4 Pushbutton Switch

Pushbutton switches – also called momentary contact switches – serve as basic user-interface devices as well as simple sensors, e.g., bump sensors. Figure 4.1 pictures the pushbutton integrated with the rotary encoder covered in a later chapter.



Figure 4-1: NImyRIO StarterKit Pushbutton Switch integrated with rotary encoder.

¹ Developed on the basis of educational materials: National Instruments, IBM, Reichle & De-Massari, Microsoft, Warsaw University of Technology, Joint Nuclear Institute Research

4.2 Learning Objectives:

After completing the activities in this chapter you will be able to:

4.2.1 Discuss the essential concepts associated with a pushbutton switch:

- [a] Pushbutton switch appears as a short circuit when pressed, otherwise as an open circuit,
- [b] Interface circuit to the digital input relies on the DIO internal pull resistors to eliminate the need for additional components (pull-up on MXP Connectors A and B, pull-down on MSP Connector C),
- [c] Block diagram views the switch as a Boolean (two-level) signal that is either active-high or active-low depending on the type of pull resistor,

4.2.2 Apply software-based edge detection to convert a pushbutton press into a trigger event.

4.3 Component Demonstration

Follow these steps to demonstrate correct operation of the pushbutton switch.

4.3.1 Select these parts from the NImyRIO StarterKit:

- [a] Pushbutton switch (integrated with rotary encoder),
<http://www.sparkfun.com/datasheets/Components/TW-700198.pdf>
- [b] Breadboard
- [c] Jumper wires, M-F (2x)

4.3.2 Build the interface circuit:

Refer to the schematic diagram and recommended breadboard layout shown in Figure 4.2 on the facing page.

TIP: Flatten the two tabs on either side of the rotary encoder so that it sits flush on the breadboard surface.

The pushbutton switch interface circuit requires two connections to NImyRIO MXP Connector B (see Figure A.1 Appendix)

- [a] Pushbutton Terminal 1 → B/DIO0 (pin 11)
- [b] Pushbutton Terminal 2 → B/GND (pin 12)

4.3.3 Run the demonstration VI:

- [a] Download
<http://www.ni.com/academic/myrio/project-guide-vis.zip>
- [b] if you have not done so previously and unpack the contents to a convenient location,
- [c] Open the project Pushbutton demo.lvproj contained in the subfolder Pushbutton demo,
- [d] Expand the hierarchy button (a plus sign) for the myRIO item and then open Main.vi by double-clicking,
- [e] Confirm that NImyRIO is connected to your computer, and
- [f] Run the VI either by clicking the Run button on the toolbar or by pressing Ctrl+R.

Expect to see a “Deployment Process” window showing how the project compiles and deploys (downloads) to NImyRIO before the VI starts running.

NOTE: You may wish to select the “Close on successful completion” option to make the VI start automatically.

4.3.4 Expected results:

The demo VI displays the input state of three DIOs, one on each connector. The states of the Connector A and B DIOs should be high due to the internal pull-up resistors, and the Connector C DIO should be low because of the internal pulldown resistor. Press the pushbutton and you should see the B/DIO0 state indicator change to low; release the pushbutton and the state should go high again.

The demo VI also counts pushbutton presses detected on B/DIO0. Stop and restart the VI to clear the counter value.

Disconnect Pushbutton Terminal 1 and reconnect to A/DIO0 (pin 11). Confirm that the A/DIO0 state indicator changes in response to pushbutton presses. Disconnect Pushbutton Terminal 1 and reconnect to C/DIO0 (pin 11). Does the C/DIO0 state indicator change in response to a pushbutton press? Can you explain the behavior you observe?

Click the Stop button or press the escape key to stop the VI and to reset NlmyRIO; a myRIO reset causes all of the digital I/O pins to revert to input mode.

4.3.5 Troubleshooting tips:

Not seeing the expected results? Confirm the following points:

- [a] Glowing power indicator LED on NlmyRIO,
- [b] Black Run button on the toolbar signifying that the VI is in runmode, and
- [c] Correct MXP connector terminals—ensure that you are using Connector B and that you have the correct pin connections.

4.4 Interface Theory

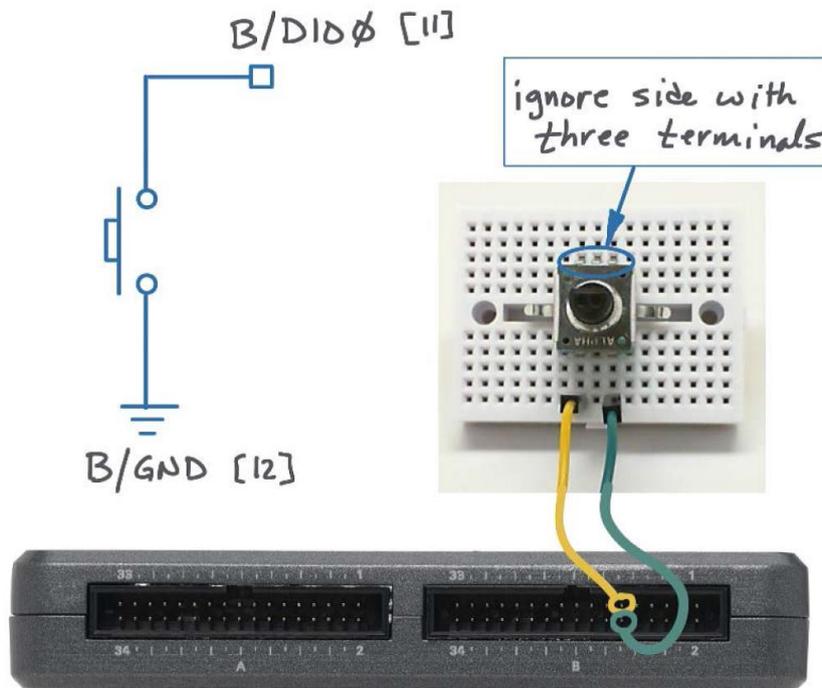


Figure 4-2; Demonstration circuit for pushbutton switch: schematic diagram, recommended breadboard layout, and connection to NlmyRIO MXP Connector B.

4.4.1 Interface circuit:

The pushbutton switch normally appears as an open circuit and becomes a short circuit when pressed. The pushbutton may be connected directly to the digital input without any additional components because of the internal pull resistors on the NImyRIO DIO lines.

Study the video *Pushbutton Interfacing Theory* (4:24)

<https://www.youtube.com/watch?v=e7UcL5Ycpho&feature=youtu.be>

to learn about the DIO pull resistors and how to properly connect the pushbutton switch for pull-up resistors (MXP Connectors A and B) and pull-down resistors (MSP Connector C).

Study Detect a *Switch Signal Transition* (4:42)

https://www.youtube.com/watch?v=GYBmRJ_qMrE&feature=youtu.be

to learn how to detect a switching signal transition inside a software while-loop structure.

4.5 LabVIEW programming:

Study the video *Digital Input Express VI* (1:53)

<https://www.youtube.com/watch?v=litswKgOmZA>

to learn how to use *Digital Input Express VI* to sense the state of the pushbutton.

4.6 Basic Modifications

Study the video *Pushbutton DemoWalk-Through* (3:16)

<https://www.youtube.com/watch?v=Xm1A4Cw2POU>

to learn the design principles of Pushbutton demo, and then try making these modifications to the block diagram of *Main.vi*:

- [d] Add the on board LED Express VI (myRIO | Onboard subpalette) as an indicator on the output of the edge detector (the AND gate).
- [e] Confirm that the LED flashes briefly when you press the pushbutton.
- [f] Experiment with different values of loop speed by adjusting the value of Wait (ms); you may find it more convenient to change the constant to a front-panel control. At what value does the VI introduce noticeable delay responding to the pushbutton press?
- [g] Adjust the presses counter behaviour to count pushbutton releases instead of presses.
- [h] Adjust the presses counter behaviour to count both pushbutton presses and releases. HINT: Try a single exclusive-OR gate from the Programming | Boolean subpalette.
- [i] Modify the loop termination condition so that the VI runs only while the pushbutton is pressed.

NOTE: The **SPST** (Single Pole Single Throw) slide switch included with the NImyRIO StarterKit (see Figure 4.3) can connect to myRIO in the same way as the pushbutton switch. Simply use the middle terminal and either end terminal in place of the pushbutton terminals. Use the slide switch anytime you need to maintain the DIO at a specific level, for example, as a mode setting for your NImyRIO program.

4.7 For More Information

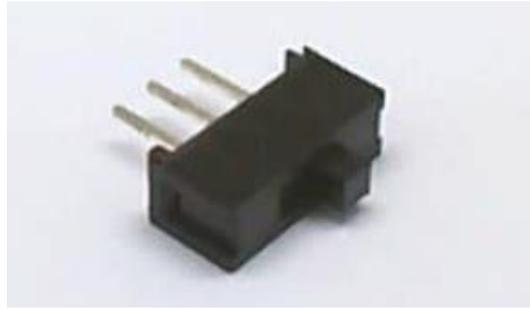


Figure 4-3; SPST (Single Pole Single Throw) switch included with the NlmyRIO StarterKit.

Mini Push Button Switch by SparkFun - A handy switch for circuit boards:

<http://www.sparkfun.com/products/97>

Applications by Knitter-Switch s Learn about the myriad practical applications for switches as well as the wide variety of switch types:

http://www.knitter-switch.com/p_applications.php

Bibliography:

- [j] www.jinr.ru
- [k] www.ni.com
- [l] www.nica.if.pw.edu.pl
- [m] The Multi-Purpose Detector – MPD to Study Heavy Ion Collisions at NICA; (CDR Conceptual Design Report) Version 1.4; Project leaders: A. N. Sissakian, A. S. Sorin, V. D. Kekelidze.
- [n] <http://www.sparkfun.com/datasheets/Components/TW-700198.pdf>
- [o] <http://www.ni.com/academic/myrio/project-guide-vis.zip>
- [p] <https://www.youtube.com/watch?v=e7UcL5Ycpho&feature=youtu.be>
- [q] https://www.youtube.com/watch?v=GYBmRJ_qMrE&feature=youtu.be
- [r] <https://www.youtube.com/watch?v=litswKgOmZA>
- [s] <https://www.youtube.com/watch?v=Xm1A4Cw2POU>
- [t] <http://www.sparkfun.com/products/97>
- [u] http://www.knitter-switch.com/p_applications.php